James R. Sproule, MD, CCFP(EM)

Hockey Injuries

SUMMARY

Hockey, Canada's national sport, is probably the world's fastest team sport. The nature of the game makes injuries a common occurence. This article reviews the literature on hockey injuries and identifies some of the changing trends over the past 15 years. Severity and incidence of injuries increase with the age and skill level of the player. There are fewer lacerations, eye injuries, and head injuries since helmets and facial protectors have become mandatory in minor hockey. However, there has been an increase in spinal cord injuries. Physicians who provide medical coverage for older adolescent and adult competitive élite hockey players should be proficient at assessment and acute care of patients with life-threatening injuries. (*Can Fam Physician* 1988; 34:125–129.)

RÉSUMÉ

Le hockey, sport national du Canada, est probablement le sport d'équipe le plus rapide au monde. La nature même du jeu provoque souvent des blessures. Cet article révise la littérature touchant les blessures de hockey et identifie certaines tendances au changement observées au cours des 15 dernières années. La sévérité et l'incidence des blessures augmentent avec l'âge et le niveau d'habiletés du joueur. Dans les ligues mineures, on constate une diminution des lacérations, des blessures oculaires et des blessures crâniennes depuis l'imposition des casques et des masques protecteurs. Par contre, on constate une augmentation des blessures de la colonne vertébrale. Les médecins qui assurent la couverture médicale des adolescents plus âgés et des adultes constituant l'élite compétitive doivent être compétents pour évaluer et traiter les urgences et les blessures risquant de mettre la vie des joueurs en danger.

Key words: hockey injuries, emergency medicine skills, medical supervision

Dr. Sproule practices primary-care sports medicine and emergency medicine in Ottawa. He has recently completed a one-year fellowship in primary-care sports medicine at the J.C. Kennedy Athletics Injuries Clinic at the University of Western Ontario. He has travelled with the Canadian Olympic Hockey team as Team Doctor and has been a medical officer for many sporting events. Requests for reprints to: Dr. James R. Sproule, Emergency Department, Ottawa Civic Hospital, 1053 Carling Avenue, Ottawa, Ont. K1Y 4E9

ÉLITE ADOLESCENT and adult hockey players are taller, heavier, stronger, and skate faster than in previous years. Hockey has been described as the fastest and most violent team sport. Twelve players at a time are confined to a space surrounded by rigid boards and glass, with two rigid metal posts at either end. Each player wears sharpened blades to allow him to gain tremendous speed and manoeuvrability on an extremely slippery ice surface. Each player also carries a four-foot-long curved stick, and all of them chase a hard rubber disc three inches in diameter and one inch thick that, on occasion, is propelled at speeds greater than one hundred miles per hour. Considering these circumstances, it is not difficult to appreciate the likelihood of injuries during a hockey contest.

Epidemiology

Investigators from Canada, the United States, and Europe have tried to describe and analyse hockey injuries and, more recently, have scrutinized some changing trends.[1–3]

Several investigators[4–6] have demonstrated that the incidence and severity of injuries increases with the player's age and level of skill. Increased impact forces and the increased speed of play are certainly important factors, but so are the intensity of play and the importance attributed to winning. Hockey at the junior, college, senior, and professional level has additional parameters. Monetary revenues, future career opportunities, and traditional rivalries contribute significantly to the intensity of the game. Aggressive parents, demanding coaches, and enthusiastic and occasionally barbaric fans often promote inappropriate violent behaviour by the players.

Daffner[4] showed that injuries were greatest to adult and semi-professional players who wear little or no head protection. Sutherland[5] demonstrated a marked increase in the injury rate when comparing minor, high school, college and professional hockey, in that order. Wilson's[6] study of facial injuries showed that the rate of facial lacerations increased with the age of the player and the number of years of exposure. He suggested that the rate of facial injuries in hockey would decline significantly when full facial protection became mandatory.

Most hockey injuries occur during game situations and, less often, during practice sessions. Hornof and his colleagues,[7] and Biener and Muller[8] report 55% and 70% respectively for the proportion of injuries sustained in games. The most reasonable explanation for these results would be the increased intensity and rivalries between opposing teams during game situations which are either absent or diminished during practice sessions.

Causes of Injuries

The cause of most hockey injuries is physical contact. Impact injuries involve the stick or the puck, while collision injuries occur between players (occasionally from the same team), or between players and immovable objects such as the boards, the glass, or the goal post (see Table 1).

A major percentage of hockey injuries can be attributed directly to impact with the hockey stick or puck. Comparison between the studies conducted in the early 1970s and the Ontario University Athletic Association (OUAA) study conducted by Manton and Bishop in 1986/87,[3] is noteworthy. Fewer injuries occurred as a result of impact with the stick or puck in 1986/87. This finding is likely associated with the use of head and facial protection that is promoted in Canadian college hockey.

Anatomical Site of Injury

Data from studies conducted in the early 1970s[5, 7–9] show a preponderance of head and neck injuries, with lower percentage of upper and lower extremity injuries. Table 2 demonstrates a reduction in the percentage of head and neck injuries in 1986/87[3] compared to the early 1970s. Manton[3] and Hayes[9] both specifically described injuries in college-level hockey. In all likelihood, this is related to the increased use and acceptance of helmets and face protectors.

Table 1
Cause of Injury

	Hayes (1972) (%)	Biener and Muller (1973) (%)	Hornof (1973) (%)	Manton (1986-87) (%)
Impact:				
a) with stick	29.1	25.0	— 54.0	19
b) with puck	15.2	17.0	—	13
Collisions:				
a) with players	— 38.0	17.0	15.6	36.0
b) with boards	—	—	16.6	9.0
Other	18.0	41.0	14.0	23.0

Table 2
Anatomical Site of Injury

	Hornof (1973) (%)	Biener (1973) (%)	Sutherland (1974) (%)	Hayes (1972) (%)	Manton (1986-87) (%)
Head and neck	37.1	42.0	57.5	45.1	24.9
Lower extremity	35.7	18.0	26.6	19.2	34.7
Upper extremity	21.9	21.0	11.5	17.1	29.2
Torso, other	5.3	19.0	4.3	18.6	11.2

Type of Injuries

Soft tissue injuries

Soft tissue injuries are the most common hockey injuries (74%–88%).[3, 7, 9–11] Most of these injuries are contusions, lacerations, or tendon and ligament strains and sprains. Lacerations are assessed and treated either at the game or immediately following, at the closest hospital emergency room. Studies conducted in the early 1970s report an average of 33.3% of injuries as lacerations.[7, 9, 10, 11] Manton's (OUAA) study of 1986/87,[3] reports lacerations as only 12.1% of injuries. As most lacerations occur to the head and neck, this reduction can probably be attributed to the use of helmets and face protectors.

Eye injuries

Recent work by Pashby[1] compares the incidence of eye injuries in Canadian Amateur Hockey in the 1974/75 season, when face protectors were not mandatory, to their incidence in the 1983/84 season when Canadian Standards Association-certified helmets and face protectors became mandatory for minor hockey. The overall incidence of eye injuries decreased by more than 50% (124 compared to 257 cases). The average age of injured players rose from 14 years in 1974/75 to 24 years in 1983/84. In 1983/84, only 19% of the eye injuries occurred to players less than 16 years of age, as compared to 45% in 1974/75. None of the reported injuries in 1983/84 occurred in players wearing certified equipment. The stick and the puck were responsibile for approximately 95% of eye injuries in both studies.

Pashby's[1] results strongly suggest that the mandatory use of face shields has reduced the incidence of eye injuries in minor hockey. Adult and junior hockey players have not adopted the mandatory use of face shields, and this population now represents the greater number of eye injuries. Mandatory use of face shields at all skill levels and in all age groups of organized hockey will likely reduce the incidence of eye and facial injuries even further.

Spinal cord injuries

Since the use of hockey helmets and face protectors there has been a

marked reduction in brain[2] and eye injuries.[1] The helmet and face shield, however, have been considered as possible factors contributing to an increasing number of spinal cord injuries observed between 1980 and January 1983.[2] The vast majority of spinal cord injuries occurred during organized hockey games, and all injuries involved a blow to the head, mainly by collisions with the boards. Most injuries result from a blow to the top of the head when the player's neck is slightly flexed forward (i.e., axial loading with slight forward flexion; very similar to diving accidents). The collision with the boards typically results from a check or push from behind into the boards. The group at highest risk consists of young men aged 15 to 25, playing in organized hockey leagues.[2]

The contributory factor of helmets and face shields to spinal cord injuries is not clear. Tator and Edmonds[2] suggest that poorly fitting helmets might favour forward neck flexion after impact. Many younger hockey players admit to feeling invincible and invulnerable while wearing their full protective equipment, including the helmet and face shield or mask. Hockey players are seldom advised of the risk of spinal injury and often skate directly into the boards with reckless abandon. Even for players at the élite level, muscle-conditioning programs do not promote exercises to strengthen neck muscles.

Tator[2] suggests that better enforcement of existing rules against cross-checking and new rules against checking from behind could reduce the incidence of neck injury. Neck-musculature conditioning programs similar to those in use for football and wrestling should be included in hockey conditioning. Educational programs for players, coaches, referees, and trainers, concerning the risk of neck injuries, especially when players are close to the boards, would promote safer play.

Continued research into improved helmet design could be stimulated through public-awareness programs directed at parents of minor hockey participants. Physicians and trainers who provide medical supervision at hockey games should be trained and should become familiar with the acute care of head and spinal cord injuries.

Experience at a Primary-Care Sports-Injury Clinic

The hockey injuries of patients who are assessed at a sports-injury clinic are different from those of players assessed by a trainer or physician providing medical supervision at a game or practice. Lacerations and severe head and neck injuries are not likely to be seen at a clinic. Such injuries are assessed and treated either by the team physician at the game or at a local hospital emergency room. Minor contusions and simple sprains and strains are cared for by the trainer, and players with such injuries tend not to appear at the sports-injury clinic. Most patients who do present at such clinics are referred by other physicians or by the coach or trainer, or come on their own initiative. Injuries are often acute, having occurred within the previous week, but many are chronic problems of months or years duration. Often the patient will require extensive rehabilitation and may benefit from operative management by an orthopedic consultant.

Analysis of the patient population assessed at the University of Western Ontario's J.C. Kennedy Athletic Injuries Clinic from August 15, 1986, to August 14, 1987, identifies 353 hockey injuries. Sixty-five per cent of the patients had sustained acute injuries, while the injuries of 35% could be considered chronic in nature. Sixty-two per cent of injuries had occurred during games, while 23% had occurred during practice; for 15% of patients the exact circumstances of the injury were not clear.

More than 90% of injuries involved the players' extremities, and almost twice as many lower-extremity as upper-extremity injuries (60% cf. to 33%) were recorded.

Most lower-extremity injuries were to the knee (76%) and these accounted for 46% of the total injuries. Most upper-extremity injuries were to the shoulder (64%), representing 21% of the total injuries.

Table 3 records the breakdown for the clinical diagnosis of knee injuries. Almost thirty per cent (28.8%) were ligament sprains or tears made up of medial collateral ligament (MCL), anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL) injuries, in that order.

Meniscal tears (22.5%) and patellofemoral pain (19.2%) were the next most common knee problems. Other knee injuries included patellar subluxations/dislocations, patellar bursitis and tendinitis, and patellar contusions.

Table 4 demonstrates the clinical diagnosis of shoulder injuries in hockey. Acromioclavicular separations were by far the most common shoulder injuries, representing about 40%. Glenohumeral shoulder dislocations and subluxations together represented about one-third (32.3%) of shoulder injuries. Rotator cuff tendinitis, muscular strains, contusions, and one clavicle fracture made up the rest of the shoulder injuries.

Unlike all the patients with minor soft tissue injuries documented in previous studies, most patients assessed at the sports-injury clinic had significant bone or joint injuries. Table 5

Table 3
Hockey Knee Injuries in a Sports Clinic

Clinical Diagnosis	Number		%	
Ligament injuries:				
medial collateral	27		15.6	
anterior cruciate	16	50	9.2	28.8
posterior cruciate	7		4.0	
Meniscal injury	39		22.5	
Patellofemoral pain	34		19.6	
Patellar subluxation	11		6.3	
Patellar dislocation	2		1.2	
Patellar contusion	10		5.7	
Patellar bursitis	8		4.6	
Patellar tendinitis	5		2.9	
Patellar fracture	2		1.2	
Other	12		6.9	
Total	173			

demonstrates that more than 60% of injuries were significant orthopedic problems, including ligament sprains, meniscal tears, patellofemoral problems, dislocations, and fractures.

The majority of patients seen at the sports-medicine clinic were university-age students and young adults. Because the sports clinics is located at the university, only a small proportion of patients were of the pediatric age group. Only seven out of 353 patients, about 2%, were female. Fifty-nine per cent of injuries occurred to competitive élite hockey players (varsity, junior, senior, and several professional players). Forty-one per cent of injuries occurred to players of recreational hockey. Thirty-seven per cent of patients were referred to physiotherapy for rehabilitation of their injury.

Discussion

Medical supervision at hockey games

Both the literature and common sense suggest that severe hockey injuries are most likely to occur during élite hockey games involving players over the age of 15. In these games the speed and impact forces are very high, and the intensity of the play can be enormous. Medical supervision should be available for such contests. Physicians providing medical care for these events should be familiar with assessment and acute treatment of life-threatening emergencies. Certification in Advanced Trauma Life Support and experience with airway management; head, neck, and back injuries; and abdominal and chest trauma would be excellent qualifications for game supervision. Skills and experience in the assessment and treatment of eye injuries, lacerations, and orthopedic injuries would be advantageous.

Appropriate resuscitation equipment should be readily available. This would include ambu bag, face mask and oral and nasal airways. Oxygen should be available, and intubation equipment (endotracheal tubes, laryngoscope, and stylet) is useful if the physician is experienced in its use. Large-bore catheters should be available for evacuation of a tension pneumothorax and for needle cricothyroidotomy. A stethoscope and blood-pressure cuff are essential to measure and monitor vital signs. Intravenous tubing, intravenous catheters, and bags of Ringers lactate are helpful, should fluid resuscitation be required. A good pen light, tongue depressors, and reflex hammer are useful for assessment of neurological function. A spinal board, tape, and sand bags are required for stabilization of head, neck, and back injuries.

Suture kits, local anesthetics, syringes and needles, variable-size suture material, and sterile gauze should be available for repairing simple lacerations.

Different types of splinting material, along with tape and tensors, are useful to immoblize injured limbs. Ice is usually available at most hockey rinks! Ice should be used for immediate treatment of most acute injuries. Metal eye shields should be on hand to protect injured eyes.

A major component of emergency care is the emergency protocol to be followed if a player sustains a serious injury. A signal system between the trainer and the team physician is helpful when the trainer goes out on the ice to assess an injured player. Close proximity of a spinal board and stretcher should be established. Immediate access to a telephone, beside which are the telephone numbers of the ambulance dispatch service and the closest hospital emergency room, is a necessity. Documentation of injuries should be completed to establish continuity of care and for medico-legal reasons. Chart 1 lists emergency equipment for hockey games. Chart 2 lists life-threatening injuries that could occur in hockey games.

Prior knowledge of medical problems of team members is important. Appropriate medication should be on hand, such as ventolin for the asthmatic and 50% dextrose and water for the diabetic.

Changing Trends

Pashby's comparative study of eye injuries in Canadian Amateur Hockey suggests that the mandatory use of face shields has reduced the incidence of eye trauma. Comparison of the recent study of Manton and Bishop[3] to the earlier work of Hayes[9] in élite college hockey corroborates Pashby's claim. The reduction in the proportion of head and neck injuries, stick- and puck-impact injuries, and lacerations can probably be attributed to the use of more effective helmets and face shields.

The implied relationships between the use of helmets with face shields and the increased incidence of spinal injuries is disturbing. It is inappropriate to assume a direct causal relationship and decide to accept one injury while preventing another! An educational program describing the risks of spinal injuries in hockey and the benefits of rule changes (prohibiting cross-checking and pushing from behind) should be implemented. Coaches, referees, and trainers should inform young hockey players of potential injury situations and teach them how to avoid them. A neck-musculature conditioning program would increase both neck strength and awareness of the problem. Physicians should encourage and endorse the use of quality certified equipment at all levels of hockey. Support of continued research into better helmet and face-shield design may

Table 4
Hockey Shoulder Injuries Seen in a Sports Clinic

Clinical Diagnosis	Number	%	
Acromioclavicular separation	29	39.1	
Glenohumeral dislocation	17	22.9	32.3
Glenohumeral subluxation	7	9.4	
Rotator cuff tendinitis	14	18.4	
Muscle strains	5	6.7	
Contusion	1	1.3	
Clavicle fracture	1	1.3	
Total	**74**		

Table 5
Nature of Hockey Injuries Seen in a Sports Clinic

Clinical Diagnosis	Number	%
Ligament sprains	75	27.3
Meniscal tears	30	10.9
Patellofemoral pain	30	10.9
Dislocation	20	7.3
Fractures	14	5.1
Contusions	43	15.6
Muscle strains	27	9.8
Tendinitis	17	6.2
Bursitis	14	5.1
Laceration	2	0.7
General medical	3	1.1
Total	**275**	

some day lead to safer and more effective equipment.

Conclusions

Injuries are inherent to the game of hockey. It is a dangerous sport played at high speed and with great intensity. The incidence and severity of injuries increases with the age and skill level of the players. The pattern of injuries has changed over the past 10–15 years. We see fewer injuries to the eyes and face since the introduction of helmets with face shields. Unfortunately, there has also been an increase in the incidence of spinal injuries. The medical community should adopt a leadership role in efforts to reverse this disturbing trend.

Physicians with skills and experience in emergency medicine are the most appropriate professionals to provide medical supervision at élite hockey games. Resuscitation equipment and a precise emergency protocol should be available in the event of a serious injury.

Chart 1
Emergency Equipment for Hockey Games

Essential	Useful
Airway equipment:	**Intubation equipment:**
oral airways	laryngoscope
nasal airways	endotracheal tubes
face masks	stylet
ambu bag	oxygen
	portable suction
	Large-bore IV catheter for:
	needle cricothyroidotomy
	evacuation of tension pneumothorax
Stethoscope	Intravenous catheters
Blood-pressure cuff	Intravenous tubing
	Ringers lactate
Pen light	Tongue depressor
	Reflex hammer
Spinal board and stretcher	Philadelphia collar
Sand bags	
Adhesive tape	
Suture kits	
Suture (3.0 to 6.0)	Scalpel
Sterile gauze	
Local anesthetic	
Syringes and needles	
Disinfectant	
Splints	Metal eye shield
Tensors	

Chart 2
Life-Threatening Injuries to Consider in Hockey

1. Airway injuries:	laryngeal trauma (hematoma, fracture)
	facial fractures
	aspiration of teeth, gum, mouth guard
2. Head injuries:	subdural
	epidural
	cerebral contusion
3. Spine injuries:	cervical spine–fractures, dislocations
	lumbar spine–fractures
4. Blunt trauma:	tension pneumothorax
	liver and spleen (rupture, hematoma)
	renal contusion
5. Major lacerations:	neck
	limbs

Acknowledgement

I wish to thank Ms. Irene Wonsowicz for her help in preparing the manuscript and Mrs. Susan Webster-Bogart for providing the statistics from the J.C. Kennedy Athletic Injuries Clinic in London, Ontario.

References

1. Pashby T. Eye injuries in Canadian amateur hockey. *Can J Ophthalmol* 1985; 20(1):2–4.

2. Tator CH, Edmonds VE. National survey of spinal injuries in hockey players. *Can Med Assoc J* 1984; 130:875–80.

3. Manton J, Bishop PJ. Injuries occurring in OUAA hockey during the 1986–87 season: a summary. Paper presented to the Ontario University Athletic Association Meeting, May 1987.

4. Daffner RH. Injuries in amateur ice hockey: a two-year analysis. *J Fam Pract* 1977; 4(2):225–7.

5. Sutherland GW. Fire on ice. *Am J Sports Med* 1976; 4(6):264–9.

6. Wilson K, Cram B, Rontal E, et al. Facial injuries in hockey players. *Minn Med* 1977; 13–9.

7. Hornof Z, Nápravnik C. In: Sim FH, Simonet WT, Melton LJ, et al. (ed). Ice hockey injuries. *Am J Sports Med* 1987; 15(1):30–40.

8. Biener K, Muller P. In: Sim FH, Simonet WT, Melton LJ, et al. Ice hockey injuries. *Am J Sports Med* 1987; 15(1):30–40.

9. Hayes D. Hockey injuries: how, why, who, when. *Physician and Sports Med* 1975; 3(1):61–65.

10. National Electronic Injury Surveillance System 1974. In: Sim, et al. Ice hockey injuries. *Am J Sports Med* 1987; 15(1): 30–40.

11. Rovere GD, Gristina AG, Nicastro JF. Medical problems of a professional hockey team: a three-year experience. *Physician and Sports Med* 1978; 1:59–63.